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ABSTRACT

Information on water and water resources in Ohio is presented in seven sections. Water from Ohio streams, water storage, lakes in Ohio, and ground water are discussed in the first section ("Water, A Part of the Earth"). A brief discussion on the ecosystem is provided in the second section ("Water and Life"). Topics discussed in the third section ("Water in Use") include: agriculture, irrigation and rainfall, home use, water for cities, electricity, water for industry, transportation by water, and recreation and wildlife. Activities of governmental agencies responsible for water management are outlined in the fourth section ("Water and Government"). These agencies include Ohio Department of Natural Resources, Ohio Environmental Protection Agency, U.S. Geological Survey, and others. Water problems are discussed in the fifth section. These problems include water shortage/abundance, pollution, floods, agricultural drainage, urban drainage, and sedimentation. Comments on water management and a short list of vocabulary words related to water (with definitions) are provided in the sixth and seventh sections respectively. Text material is supplemented by photographs, drawings, and several easy to read graphs. (JN)

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Water, Ohio's Remarkable Resource

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Water, Ohio's Remarkable Resource

1982
Fountain Square, Columbus, Ohio

Principal Streams in Ohio

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Contents

Water, A Part of the Earth 1
- Water from Ohio Streams 3
- Water Storage 4
- Lakes in Ohio 4
- Ground Water 5

Water and Life 6
- The Ecosystem 6

Water in Use 7
- Agriculture 8
- Irrigation and Rainfall 8
- Home Use 9
- Water for Cities 10
- Electricity 11
- Water for Industry 11
- Transportation by Water 13
- Recreation and Wildlife 14

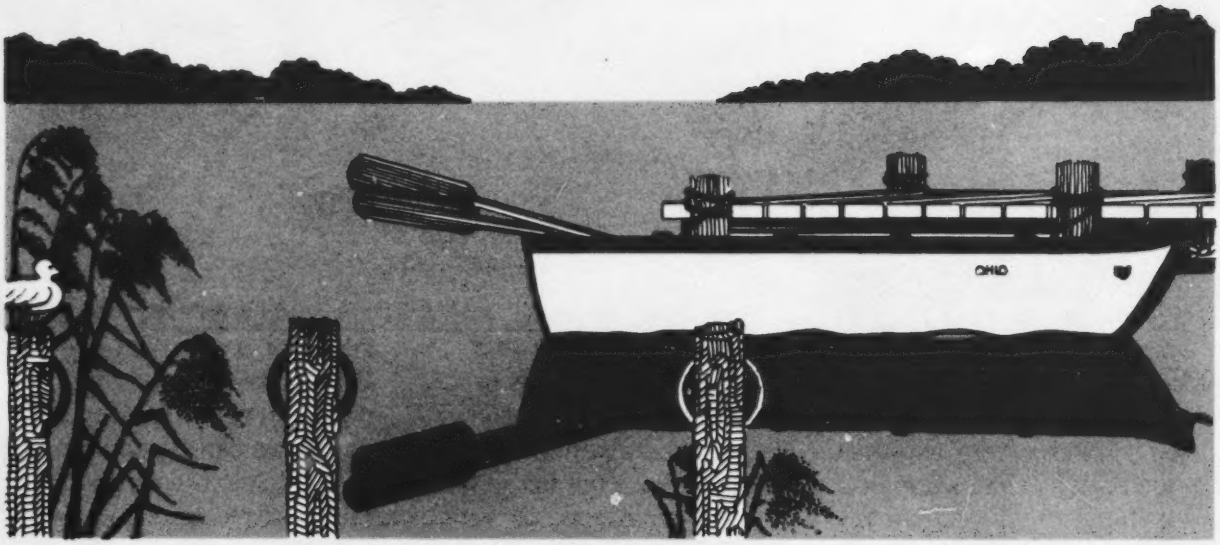
Water and Government 16

Water Problems 20
- Too Much or Not Enough 20
- Pollution 20
- Floods 22
- Agricultural Drainage 23
- Urban Drainage 24
- Sedimentation 24

Water Management 25
- What's the Answer? 25

Water Words 26

Water, A Part of the Earth



Of all substances necessary to life on Earth, water is one of the most important, the most familiar, and the most remarkable.

Think how much water you use to flush the toilet, take a shower, brush your teeth, or grind up an orange peel in the garbage disposer. What's behind that running faucet? How did the water get there?

Try to imagine the time it takes water to move from the lake or river before it finally flows out the faucet to fill your glass. Water may travel many miles through pipelines, pumps, filters, meters, tanks, valves, and tubes. Now think about water's return trip to streams and rivers to be reused at another time, in another place. Water goes down the drain and back out a maze of pipelines to be processed through a sewage treatment plant.

Sounds like a long journey for your drink of water, doesn't it? The next time you get a drink, water the lawn, wash your car, or take a bath, think of the system that brings clean water to you.

In addition to flowing across the land, water constantly moves between the land and the sky. Water evaporates from streams, rivers, lakes, oceans, moist soil, plants, and from structures built by people. It is carried in the air as water vapor, and we can see clouds when water vapor condenses. The circulation of water between Earth and atmosphere takes place because of the heat of the sun and the force of gravity. This ongoing process, in which water is continually moving from one location to another and between one form and another, is called the water cycle or hydrologic cycle.

When water vapor condenses, it falls from the sky in the form of rain, snow, sleet, or hail. Most precipitation either evaporates or runs off the land into streams. Precipitation may also become trapped in upper soil layers and soon evaporate. Gravity makes some water sink deeper into the ground and become what is called ground water. The water moves slowly through incredibly small spaces underground and eventually seeps into streams or rivers. Ground water moves only a few inches or feet a day, and usually never more than a mile or two a year. In Ohio, about two-thirds of our precipitation evaporates or soaks into the ground to be used by growing plants. The other one-third leaves the land as streamflow or recharges our ground-water supply.

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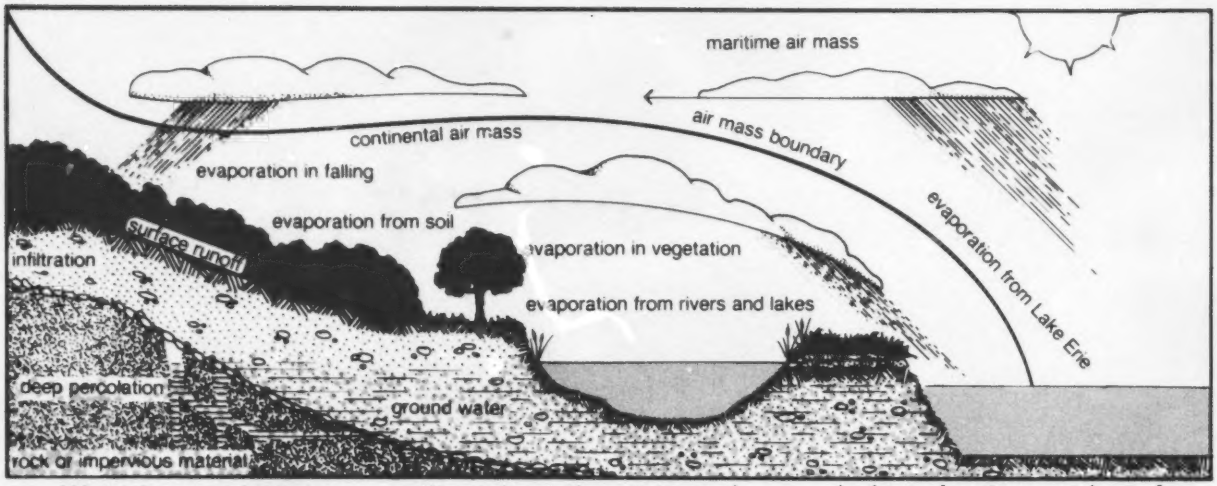


Water is never lost. Molecules of the water you drink today could have been used by other people last week or thousands of years ago. The 70 percent of your body weight that is water is replaced several times a year. As a tree grows, the water it contains is restored thousands of times. It may take from 2 to 100 years for the water in a large lake to be completely exchanged, depending on inflow and outflow rates. The ocean's water is renewed by rivers and streams about once each 3,600 years, and the water forming polar ice is replenished once in 15,000 years.

How much water do we have? The amount of rain, snow, sleet, and hail that falls over Ohio averages 38 inches a year. That is a lot more water than many southwestern states receive, where precipitation may be less than 10 inches a year. The amount of precipitation varies from as little as 26 inches to more than 50 inches from year to year in Ohio.

Ohio's precipitation is fairly evenly distributed throughout the state and throughout the year. We usually receive about 2.3 inches in February, our driest month, and 4.0 inches in June, the wettest. Our monthly average of precipitation is 3.2 inches. More precipitation falls in southern Ohio (44 inches per year average) and less in areas closer to Lake Erie (32 inches per year average).

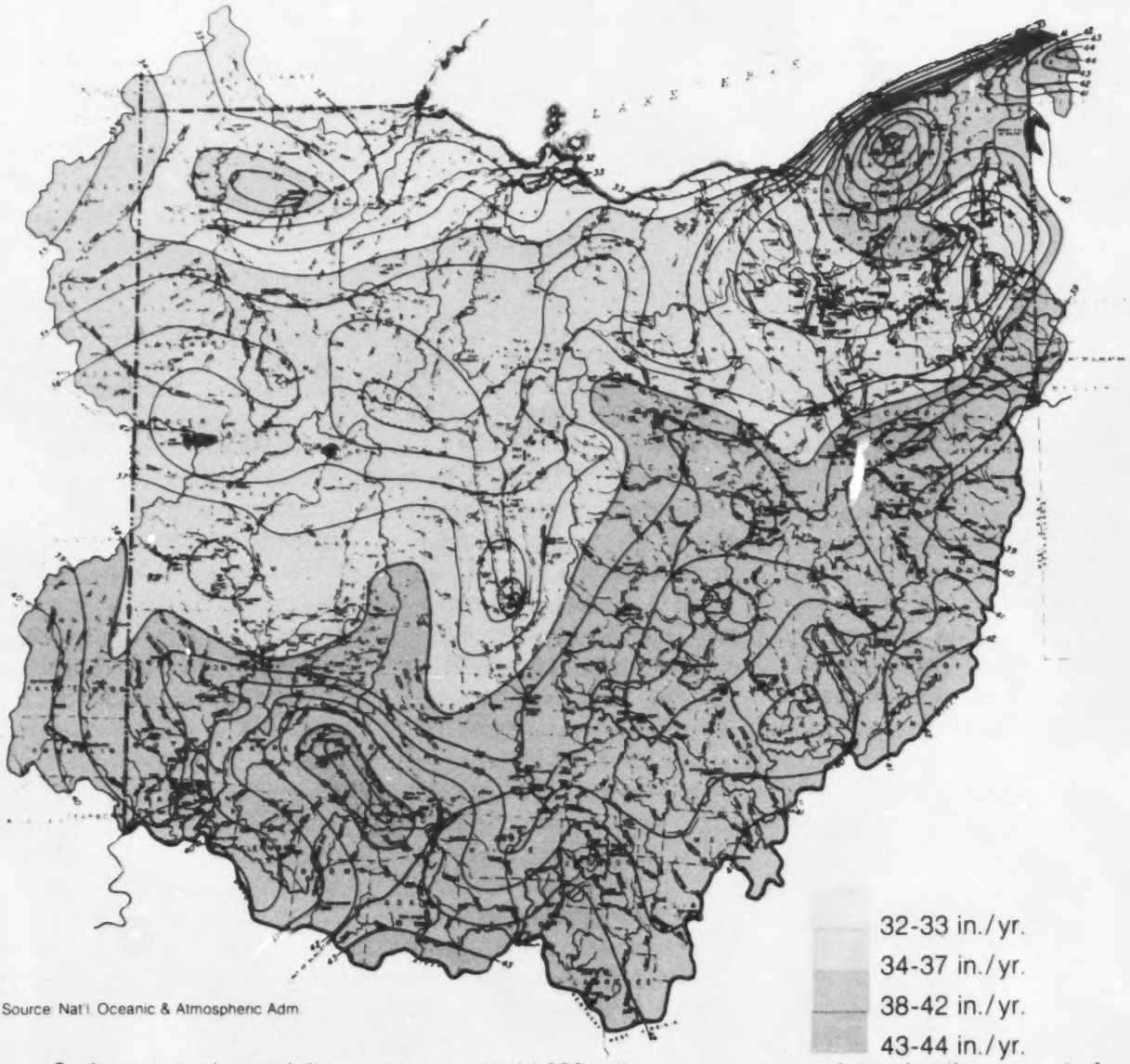
We use only a portion of Ohio's 38 inches of average yearly precipitation. Most of the water returns to the air as vapor by evaporation from land and water surfaces and by transpiration (release of moisture) from living plants. The processes of evaporation and transpiration work at the same time and together are called evapotranspiration. This is essential for plant growth (a source of our food supply).

About 25 inches of our average yearly precipitation in Ohio is lost to evapotranspiration, leaving about 13 inches of water a year for runoff to streamflow and underground discharge, which can be used for water supply. Thirteen inches of water are plenty for Ohio's present needs; much more can cause flooding and much less can cause drought. Most of Ohio's water problems result from too much water rather than too little.

The amount of water available for Ohio's use from streamflow averages over 25 billion gallons a day. This is nearly twice our average total daily use. In addition, we have two more sources of water. More than 110 billion gallons of water a day drain into Lake Erie from places outside Ohio such as the Detroit River and southern Ontario. Farther south, the Ohio River carries nearly 60 billion gallons past Cincinnati every day—42 billion gallons of which come from non-Ohio watersheds. In all, we receive nearly 194 billion gallons a day from rainfall over Ohio and from water draining to Ohio from surrounding areas. That's a lot of water.

Water from Ohio Streams

Average Annual Precipitation 1931-1960



Source: Nat'l. Oceanic & Atmospheric Adm.

Surface water is precipitation that runs off the land into rivers and streams. Surface water provides 19 out of every 20 gallons of water we withdraw for use in Ohio.

Ohio has more than 3,300 streams we've given names and probably as many smaller, unnamed tributaries. The combined length of named streams is 44,000 miles—almost long enough to circle the Earth twice. The water surface area of Ohio streams is about 41,000 acres or 64 square miles. Nearly one-fourth of our stream mileage flows toward Lake Erie, the rest to the Ohio River.

The amounts of precipitation and season of year determine the amount of streamflow. Withdrawal uses also affect streamflow levels. In Ohio, streamflow is usually lowest in the late summer or fall due to less precipitation and more evaporation and transpiration. About 75 to 90 percent of our late summer precipitation is lost to these processes.

3

Water Storage

We normally use about the same amount of water each work day, but the amount of rainfall is not regular or constant. Communities and industries depending on surface-water supplies find that sometimes there is too much water and at other times much too little. Therefore, water must be collected or stored. In Ohio, this usually means building a reservoir in the form of a lake or pond. Water supply reservoirs fill, and the water can then be released evenly during the year. This is just one of the many uses we make of Ohio's water resource. Flood control reservoirs, for instance, are kept low so they can fill with flood waters. Many reservoirs control floods, provide recreation, help fish and wildlife production, and provide water for irrigation and navigation.

Lakes in Ohio

There are more than 60,000 lakes, ponds, and reservoirs in Ohio. Almost all of these—about 200,000 acres of water—were built by people. A small area is in natural lakes—about 6,700 acres of water. Ohio's lakes, ponds, and reservoirs come in all sizes. They range from tiny ponds of only a fraction of an acre to huge reservoirs covering thousands of acres. Small farm ponds under two acres make up most of the number of water areas in Ohio.

Some of Ohio's biggest lakes were built during the 1830's to supply water to the new canal system. The canals were once vital transportation routes through Ohio. Today, we no longer use the canals for transportation, and many of the large feeder lakes are now recreation areas. Buckeye Lake, Grand Lake St. Marys, Indian Lake, Lake Loramie, Portage Lakes, and Guilford Lake were once part of the canal system.

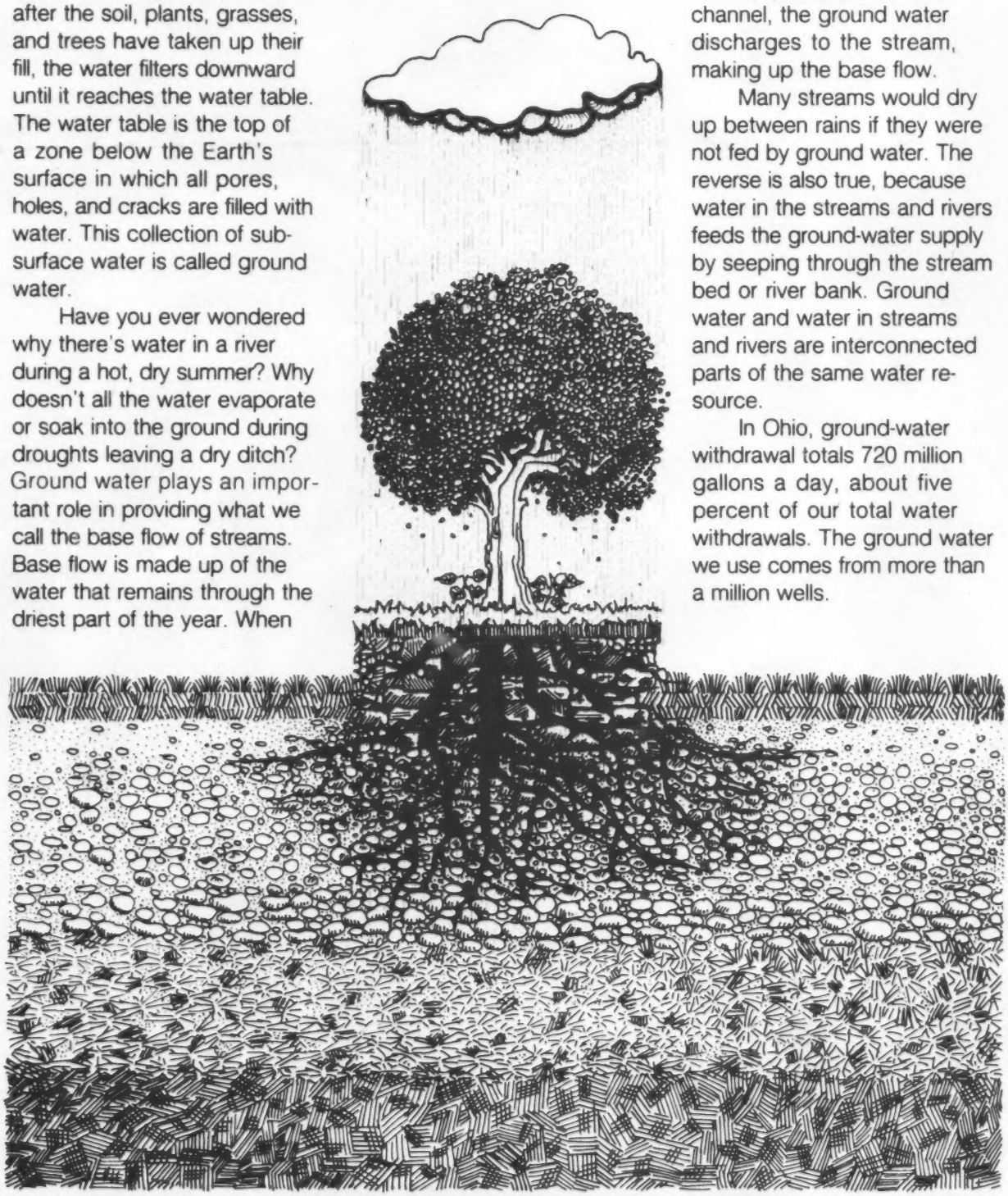
Ground Water

As rain and surface water soak into the ground, and after the soil, plants, grasses, and trees have taken up their fill, the water filters downward until it reaches the water table. The water table is the top of a zone below the Earth's surface in which all pores, holes, and cracks are filled with water. This collection of subsurface water is called ground water.

Have you ever wondered why there's water in a river during a hot, dry summer? Why doesn't all the water evaporate or soak into the ground during droughts leaving a dry ditch? Ground water plays an important role in providing what we call the base flow of streams. Base flow is made up of the water that remains through the driest part of the year. When the water table is high enough to be exposed in the stream channel, the ground water discharges to the stream, making up the base flow.

Many streams would dry up between rains if they were not fed by ground water. The reverse is also true, because water in the streams and rivers feeds the ground-water supply by seeping through the stream bed or river bank. Ground water and water in streams and rivers are interconnected parts of the same water resource.

In Ohio, ground-water withdrawal totals 720 million gallons a day, about five percent of our total water withdrawals. The ground water we use comes from more than a million wells.



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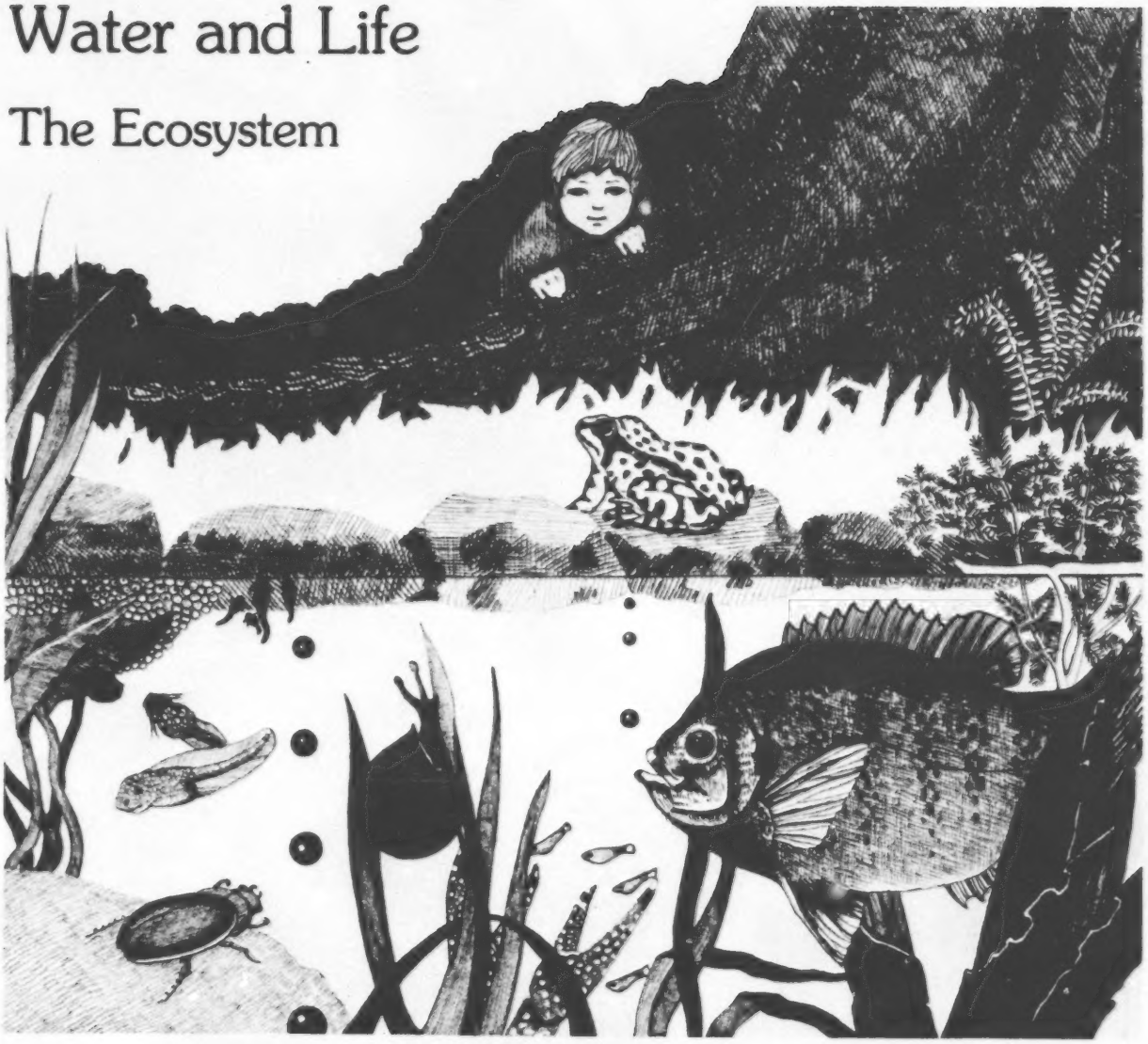
Water and Life

The Ecosystem



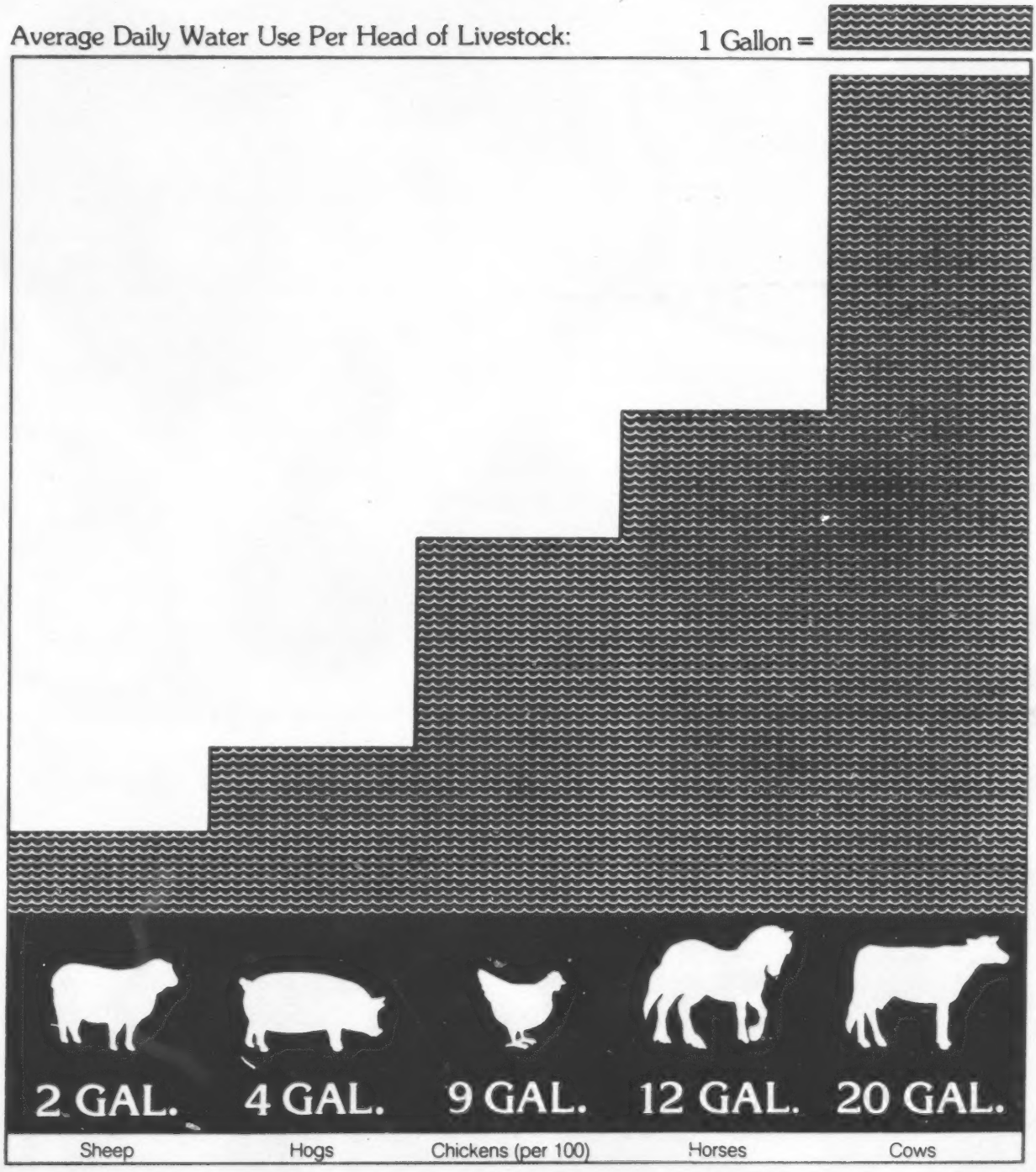
Water is one of Ohio's essential resources. Our bodies are 70 percent water, and to survive we must drink or eat food containing at least 1.5 quarts of water every day. People have gone weeks without food, but only a few days without water. For us, and for all other life, there isn't anything we can substitute for it. It's important to see how we rely on water.

We, as humans, can make big changes in our environment. We have built dams across streams so we can store water and prevent floods, and we have drained wetlands to provide more land for farming and other uses. However, it is not really possible to change just one thing in an ecosystem without affecting everything else. For example, some people might dispose of waste water by "throwing it away" in a nearby stream. However, others downstream then have to spend money to clean the water before it is safe to use.

If we look at the wonderful world of water, we find it has relationships with everything on Earth. All of us and the air we breathe, the water we drink, the food we eat, the soil we rely on, and other plants and animals we live with, are part of the world ecosystem. An ecosystem can be as small as a mud puddle or as large as an ocean. It all depends on what you want to study.

Water in Use

Agriculture



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Agriculture

Plants, like people, need lots of water. Their root systems absorb water and nutrients from the soil so the plant will grow and stay healthy. Of course, some plants require much more water than others. Most of the plants that are important to us for food and fiber need large amounts of water. The 38 inches of annual precipitation is well distributed in Ohio and contributes to making the state an important farming area.

It takes 300 gallons of water to produce the grain used to make one loaf of bread and more than 2,500 gallons of water to process one pound of beef. A dairy cow requires an average of 30 gallons of water each day to produce 4 gallons of milk. In Ohio, a corn plant requires an average of 33 gallons of water per season. Can you think of any foods we eat that do not contain water or that do not need water to grow?

Where do farmers get the water they need? For crops, most of it comes from rain that falls on the fields. Most water for home or livestock use comes from wells or farm ponds. Farm home water withdrawal in Ohio adds up to about 20 million gallons a day, almost 50 gallons per person. More than 60,000 farm ponds have been built in the state to provide water for farm livestock use, for recreation, and to fight fires. Farmers need to be able to get water easily and inexpensively.

Why is Water Important to Plants?

It helps them grow. Plants wilt and die without enough water.
It moves nutrients from the soil through the roots to the leaves.
It reacts with carbon dioxide to produce food for the plant.
It helps move the food to other parts of the plant.

Irrigation and Rainfall

Did you know that you irrigate land every time you water your lawn? Irrigated farmland in Ohio is usually watered by sprinklers—not much differently than the way you water the lawn. Farmers in Ohio get most of their water for irrigation from nearby streams, farm ponds, or wells. Some farmers close to cities raise their crops in greenhouses and may buy water from the city system for irrigation purposes.

Most golf courses require irrigation. You may be surprised to learn that golf course irrigation requires more water than all other types of irrigation in Ohio combined.

Irrigation in Ohio started before 1900. It has been slowly increasing as a farming practice for high-value farm products such as fruits and vegetables, which require uniform moisture. Nearly 1,500 Ohio farmers add water to about 50,000 acres of their croplands when it does not rain enough during the growing season. These figures vary greatly from year to year depending upon the weather.

In the United States, 60 million acres—an area more than twice the size of Ohio—are irrigated, mostly in the West. More than half the water withdrawn for use in our country is for farmland irrigation. However, in Ohio less than one percent of our water withdrawals are for irrigation. In a normal

100-day growing season, we withdraw 133 million gallons of water a day for cropland and golf course irrigation. That is less water than the Columbus city system uses in two days.

More than 40 percent of all cropland acres irrigated in Ohio grow fruits and vegetables, another 19 percent is in field corn, 16 percent in potatoes, 10 percent in hay and pasture, 6 percent in nursery plants, and all other crops irrigated total 8 percent. Golf courses total about 21 percent of the irrigated lands in Ohio. Well-maintained, green fairways are such popular golfing surfaces that every year more irrigation systems are installed at golf courses.

Irrigation water is consumed rather than used. Water taken up by the plant is lost through transpiration or evaporation from the plant or soil surface instead of returning to the streams to be used again. About 90 percent of irrigation water is consumed and can't be immediately used again by people until it returns to land as precipitation by way of the hydrologic cycle.

Home Use

All of us have a daily requirement to use water in our homes. Sinks, bath tubs, showers, toilets, washing machines, and dish washers are a few of the items found in many homes that help us use water whenever we want it. We use an average of 4 to 7 gallons of water each time we flush a toilet, 30 to 40 gallons for every bath, 3 to 5 gallons a minute for a shower, and 10 gallons to wash a load of dishes.

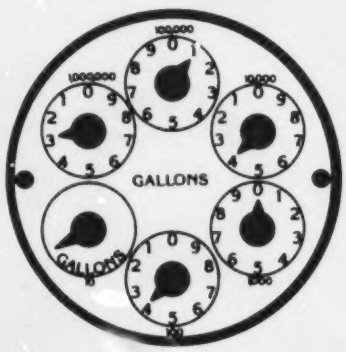
Each person in your family probably uses from 70 to 150 gallons of water every day. In Ohio, with a population of 10.8 million people, our public water systems distribute an average of 1.5 billion gallons of water daily. In addition to water for home use, public water systems supply water used by business and industry, by local fire departments, and for street cleaning. Of every 100 gallons of water supplied by community water systems, 53 gallons are used by industry, 39 gallons are used in the home, 6 gallons are used by businesses, and 2 gallons are used by the fire department. Industries and power producers also use an additional 12 billion gallons a day provided from their own private sources.

If you want to know how much water you and your family use in a day, try the "Meet Your Meter" experiment. Find the water meter in your home and record the figures every day for a week to see how much water your family uses.

Meet Your Meter

Most meters record gallons, much like your car records miles. But some show cubic feet of water used. For these, just multiply the figure shown by 7.5 to find gallons.

If you have a circular-style meter, read each dial (counter clockwise) to find the total. If a pointer is between two numbers, read the lower number.



Water for Cities

In Ohio today, there are nearly 1,700 community water systems (as defined by the Federal Safe Drinking Water Act, as amended) that provide running water at our fingertips. The first Ohio city to build a public water system was Cincinnati in 1820. Bucyrus put in the first water purification system in the state in 1887.

Supplying water to our cities has now become big business. Most of our city water systems are publicly owned, although a few Ohio cities are served water by private companies. For example, Ashtabula, Mentor, Marysville, Tiffin, and Washington Court House are cities that buy their water from private companies.

Electricity

Most power plants in Ohio generate electricity by burning coal to change water into steam. The steam builds up pressure and turns gigantic turbines which drive the electric generators. The process produces electricity and a lot of heat energy. Huge amounts of water are required to keep the system cool. According to the U.S. Water Resources Council, Ohio steam electric plants withdraw 10.3 billion gallons of water every day for steam and cooling. That's more than seven times the amount used in homes, businesses, industry, and agriculture all put together.

The nuclear power generating process creates 40 percent more waste heat than fossil-fuel plants and requires much more cooling water. The next time you turn on your TV, remember that water for electric power generation helped make it possible!

Water for Industry

Can you believe it takes more than 95,000 gallons of water to make a car? That's more than 400 tons of water for 1.5 tons of automobile. Next to steam-electric generation, industry is presently our biggest water user. Water is a necessary industrial raw material. Practically every product we use requires water somewhere in its manufacturing process.

Steel mills, chemical manufacturers, rubber factories, paper mills, and food processing plants are all big water users—they use tons and tons of water. The paper in a single copy of this booklet took 35 gallons of water to produce. On a larger scale, that's as much as 184,000 gallons for every ton of fine book paper. A large portion of industrial water is used for cooling functions to carry away waste heat and to protect equipment and machinery during high-temperature processes.

Even with all these important uses of water in industry, industrial water use has recently been decreasing. This is because of water conservation efforts. In many cases, industries have been able to save money by using less water. When a factory withdraws water from a lake, stream, or well, this water must be carefully treated before it enters into the manufacturing process and later when it leaves to be returned to the environment. This water-supply and waste-water treatment can be expensive! So, when a factory manager can think of ways to use water twice or several times over again, it means less water must be treated. This saves money. And it conserves water.

Product	Average Water Withdrawal
Rayon	200,000 gal. per ton
Steel	65,000 gal. per ton
Paper	60,000 gal. per ton
Packed Meat	6,000 gal. per ton
Canned Tomatoes	60 gal. per bushel
Corn Syrup	35 gal. per bu. of corn
Gasoline	10 gal. per gallon
Milk	5 gal. per gallon

Major Water Use in Ohio

Type of Water Use (In Million Gallons per Day; MGD)		Million Gallons per Day	Percent
Power	Thermal Electric	10,280	73%
Manufacturing	Private Supplies	1,880	14%
Public Supplies	Industrial and Commercial (635 MGD) Domestic and Losses (805 MGD)	1,440	10%
Other	Sand and Gravel Limestone Coal Cleaning Plants Railroads Miscellaneous Industry	270	2%
Rural	Homes and Livestock (90 MGD) Irrigation (80 MGD)	170	1%
Total		14,040	100%

Transportation by Water

With Lake Erie to our north and the Ohio River to our south, Ohio is close to two great inland waterways. They provide quick, low-cost routes to ship millions of tons of iron ore, grain, fuel oil, limestone, and coal.

The ports on Lake Erie and the Ohio River are busy places and the tremendous amount of goods shipped through them puts our state fourth in the nation in shipping volume.

Ohio's Lake Erie shoreline is part of the "fourth seacoast of the United States." In 1979, freight handled by Ohio's major lake ports totalled more than 98 million tons, an increase of 11 million tons over the 1974 total. Nearly one-third of all Great Lakes freight is loaded or unloaded in Ohio ports. Toledo is the largest coal shipping port on the Great Lakes. Cleveland, Conneaut, Ashtabula, Toledo, and Lorain receive huge shipments of iron ore for steel manufacturing.

Two very important assets to water transportation are associated with Lake Erie—water levels that remain stable nearly year-round and well-maintained harbors that are deep enough for access by the large lake and ocean freighters.

The Ohio River carries an increasing amount of freight. In 1930 the weight of all Ohio River traffic was 22 million tons. This grew to 151 million tons in 1977 and is still increasing.

Two-thirds of the freight traffic on the Ohio River is made up of bulk forms of energy such as coal, crude oil, and petroleum products. Other major items transported are sand and gravel, iron and steel, chemicals, and grain. The chief port city on the Ohio River is Cincinnati.

In Ohio we have been moving products by water for more than 150 years. The canal system, which connected Lake Erie and the Ohio River, played an important role in the economic development of our state during the 1800's. Canal use in Ohio peaked early in the 1850's. Then railroads were constructed across Ohio and the canal business began to decline. The railroads were faster and they ran in all weather. Canal boats could be stopped by frozen water. The big flood in 1913 destroyed many stretches of Ohio canals and ended any thoughts about their repair.

Recreation and Wildlife

You probably enjoy one or more water sports such as swimming, fishing, boating, sailing, water skiing, or scuba diving. Perhaps you just like watching a peaceful lake or lazy river. Having a lake or river near your picnic area, hiking trail, or camp site can make your outdoor fun even better. There's a seemingly endless demand for water recreation areas in Ohio.

Ohio's waters support many recreational activities. Lake Erie, the Ohio River, and our inland lakes and streams are popular areas to rest, relax and play.

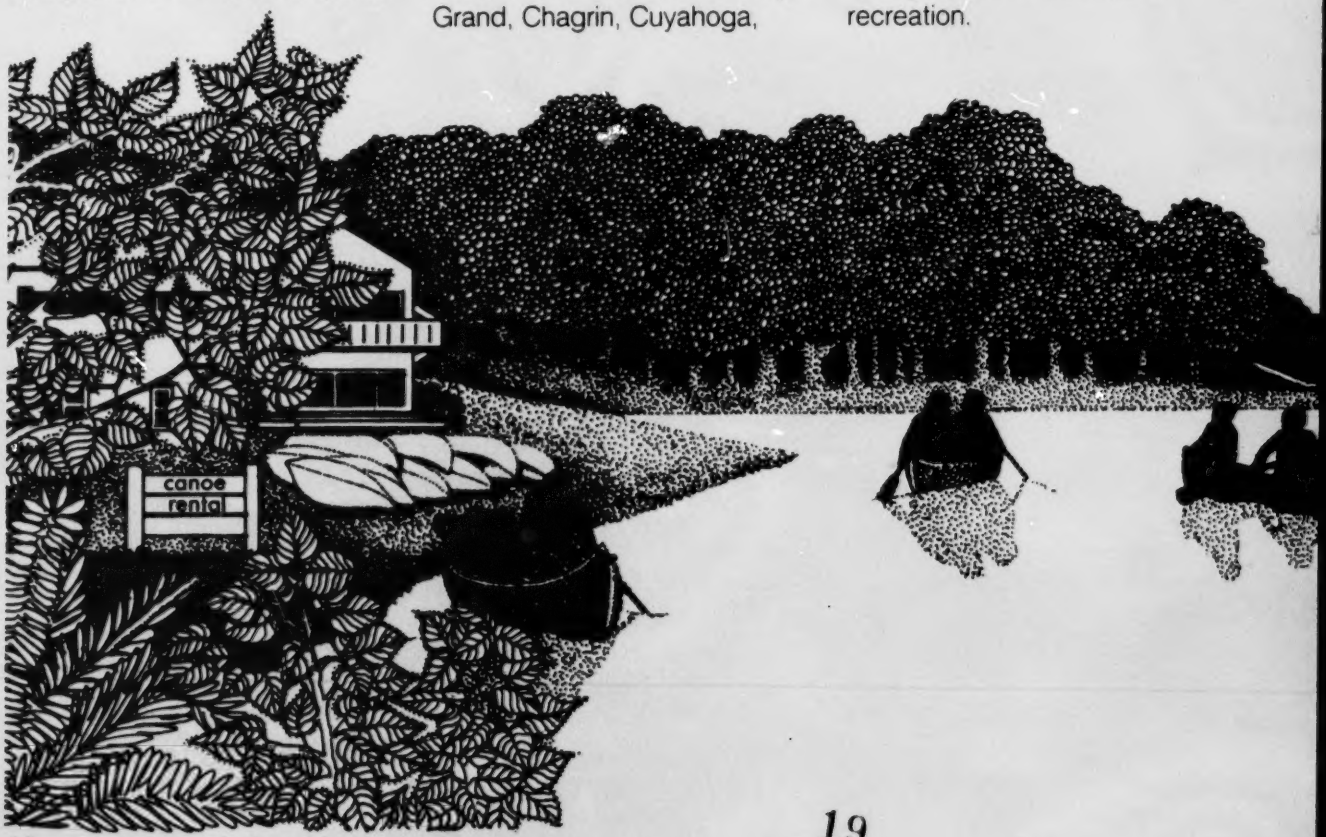
Ohio has 44,000 miles of named streams and rivers, 262 miles of Lake Erie shoreline, and more than 200,000 acres of lakes and reservoirs without including the 2.25 million acres of Lake Erie that are within Ohio.

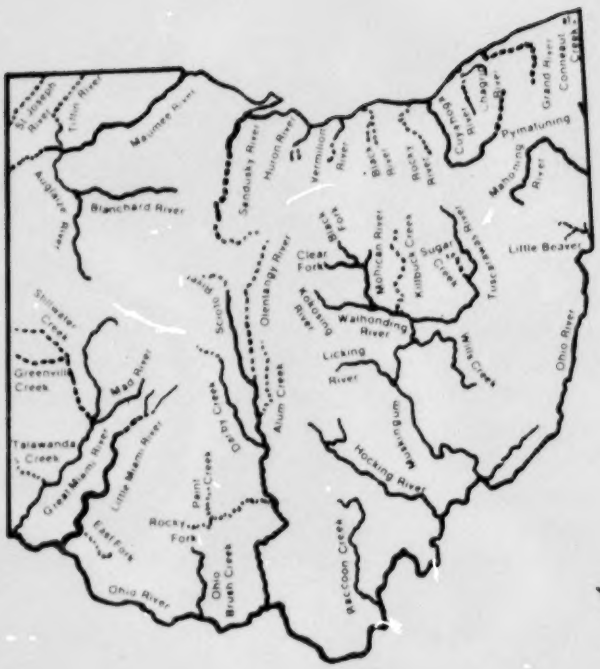
We put lots of recreational pressure on these important water resources. For instance, there are more than a million people licensed to fish each year in Ohio.

More than 450 miles of river have been identified under the Ohio Scenic Rivers Program. Ohio pioneered river preservation with passage of the nation's first Scenic Rivers Act on February 28, 1968. Sections of the Little Miami, Stillwater, Maumee, Sandusky, Grand, Chagrin, Cuyahoga, Little Beaver, and Olentangy Rivers are now part of Ohio's State Scenic Rivers System. The Little Miami River and Little Beaver Creek are also part of the National Wild and Scenic Rivers System. The Little Miami River is the nation's only urban river to be included in the national system. An urban river is one which flows through a large city.

Water areas are also rich in wildlife. Every fall more than 100,000 trappers harvest a fur crop worth nearly $2 million from water areas in Ohio.

Multiple-use reservoirs, lakes, farm ponds, rivers, and streams will continue to provide a large part of our water recreation.





Seasonally Canoeable

Canoeable Year-Round

Scenic River, Seasonally Canoeable

Scenic River, Canoeable Year-Round

Scenic River

15

Water and Government

There is more than enough fresh water on the Earth to meet everyone's needs; the problem is that it is not always in the right place at the right time. So for centuries people have been busy moving huge amounts of water from one place to another. People also moved to water, as our cities and villages grew up at the water's edge.

We have created many governmental agencies to manage water—finding it, cleaning it, storing it, moving it, and settling arguments about who can use it. However, water is not bound by the imaginary political lines that we, as people, find very real. Water management takes teamwork. Governmental agencies and the public must plan and act together to make the best use of water resources.

There are many agencies with water management responsibilities. Activities of some of the major state and federal organizations are described in the following sections.

Conservancy Districts

A conservancy district in Ohio may be created for any or all of the following purposes: to build structures to control flooding, regulate or divert stream channels and streamflow, reclaim wetlands, provide irrigation, conserve water, supply water, dispose of sewage, or solve erosion problems on the Lake Erie shoreline. Most districts in Ohio have been organized to control flooding.

Passed in 1914, the Ohio Conservancy Act was the basic start for water management using flood control structures such as dams, dikes, and levees in the United States. This was an Ohio "first." The law resulted from the March 1913 flood disaster that hit

a widespread area of Ohio as well as many other parts of the United States. Since the law was passed, some 15 states and the Province of Ontario have used the Ohio Conservancy Act as a model for similar water management laws.

The Upper Scioto Drainage and Conservancy District was the first district organized (in 1915) under the Conservancy District Act. There are now more than 18 Ohio conservancy districts managing local land and water resources.

Cooperative Extension

County extension agents are local representatives of the Cooperative Extension Service of The Ohio State University and the U.S. Department of Agriculture. The agents supply information and literature for the general public and for professionals in water management. The county agent may help landowners, homeowners, and farmers by giving advice on locating a well, laying drainage tile, planning an irrigation project, or installing a septic tank and leach bed. The extension agent's fundamental task is education—passing on knowledge developed at our universities and experimental farms.

Ohio Department of Natural Resources (ODNR)

The Division of Water within ODNR provides communities with recommendations for developing the most economical sources for water supply. Sometimes the Division can help the community request state funds to pay part of the cost of the water supply project. The Division also provides information on past floods and coordinates the federal flood insurance program in Ohio. When people are thinking of buying or building a home or business, they often check with the Division of Water to make sure the site is not regularly flooded.

The Division of Water provides ground-water information to homeowners, cities, and industries thinking of drilling wells. Precipitation and stream flow data are also available.

The Division reviews engineering plans for dams more than 10 feet high and regulates their construction by permit to make sure the dams will be safe after they are built. Existing dams are inspected periodically by the Division to see that their continued operation does not create a threat to the lives and property of Ohioans.

The Division of Water also works with local governments to make sure Ohio's Lake Erie coastal area resources are used wisely.

Other divisions within ODNR have water-related responsibilities and programs. The Division of Soil and Water Conservation has a district office for every county in Ohio. These organizations conduct analyses of soil erosion and develop plans to control serious erosion. The Districts have natural resource management programs in each Ohio county.

The Division of Wildlife is expanding fishing opportunities through the FishOhio program. The Division of Watercraft handles boat registrations and licensing and provides water safety courses for the benefit of the general public.

Ohio Environmental Protection Agency (Ohio EPA)

The Office of Public Water Supply of the Ohio EPA manages a statewide comprehensive public water supply program to guarantee safe drinking water. The Ohio EPA also protects our ground water from contamination. It tests and studies public drinking water supplies throughout Ohio. The Ohio EPA issues permits to control the quality of industrial and public waste-water discharge which might otherwise pollute our rivers and wells.

The Ohio River Valley Water Sanitation Commission (ORSANCO)

This commission was established in 1948 through an agreement among eight of the states that drain into the Ohio River. The agency's objective is to work together to protect the quality of the river. The agency works to improve waste-water discharges from cities and industries along the river through self-enforcement.

Ohio is a member of the commission, and ORSANCO headquarters are in Cincinnati. One important aim of ORSANCO is to take away any unfair advantage a state that is easy on polluters might have in attracting industry over more strict enforcers of pollution regulations.

Ohio Department of Health

The state health department, in cooperation with each county in Ohio, issues permits to install and operate private water supply systems and household sewage disposal systems. Its rules regarding water supply apply to wells, springs, ponds, and cisterns providing water for people in areas where no public water systems exist. There are separate rules for private sewage disposal systems where no public sewers and sewage treatment systems exist. The standards that the health department enforces for private water systems are the same as those adopted by the Ohio EPA for public water systems.

U. S. Army Corps of Engineers (COE)

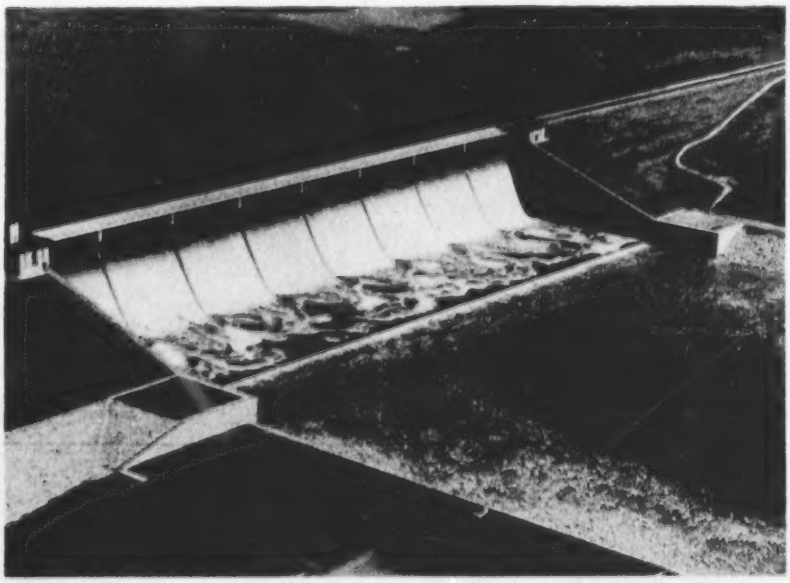
The COE plans and builds major projects that are primarily used for flood protection and navigation. Many of the flood protection reservoirs built by the COE also provide recreation, water supply, and fish and wildlife habitat. Costs of the projects often are shared between the federal government and the local community. State governments and users also help play these costs.

The COE also improves harbors and channels in Lake Erie ports. Harbors are maintained by the COE. This consists mostly of dredging sediment to control water depth and repairing breakwaters.

In Ohio, the Department of Natural Resources coordinates all COE projects and works with COE staff to prepare regional plans for water management.

U. S. Geological Survey (USGS)

The USGS measures and analyzes the flow of water in Ohio streams. Local governments, state governments, and conservancy districts help pay for the cost of stream gaging. The USGS also studies groundwater location and quantity throughout Ohio. It gathers and publishes information on water quality, water supply, and other water-related subjects. These basic data are valuable to water users, consulting engineers, governmental agencies, and agricultural and industrial interests.



U. S. Soil Conservation Service (SCS)

Every Ohio county has an SCS office that furnishes information and in-the-field technical advice on soil and water resources, such as farm pond construction and soil erosion reduction, by working through the county soil and water conservation district. The SCS provides floodplain information to local governments. SCS also helps set up and carry out small watershed protection and flood prevention programs under federal Public Law 83-566.

From this brief review of governmental agencies, we can get a better picture of our water resource and how it affects our lives. Public agencies can compile, study, and analyze enough data to help point the way. They won't solve all the problems. They can help you understand water problems, which is the first step in finding answers. From there it takes willingness to work hard, leadership, engineering skills, and money to construct a water project or implement a successful water program. People, and local, state, and federal agencies make the job easier by working as a team.

Water Problems

Too Much or Not Enough

Are we running out of water? Are the wells drying up? Does Ohio face a water shortage now or is a shortage expected in the near future?

State water planners and managers are not predicting statewide water shortages in Ohio. Ohio is rich in water resources. The water table isn't steadily falling and our streams flow as abundantly as ever. You remember that Ohio has 194 billion gallons a day available to use, and we can use it several times before it leaves the state. We actually withdraw only 14 billion gallons a day.

We can compare storing food between harvests to avoid food shortages and storing extra water during spring floods to avoid water shortages in dry seasons. Our cities spend millions of dollars every year to treat and distribute stored water so we can have enough safe, clean water to drink. Because our cities manage their water so well, we have ample water for growth and industrial expansion. Our water supply is more limited by money than it is by the water resource itself. Water has been a good bargain for all of us for a long time—maybe too long.

To have water when and where we need it, cities must build reservoirs and water purification plants and lay hundreds of miles of pipelines connecting the reservoirs, treatment plants, and homes. It all costs money, and some city governments still don't charge the water users enough to pay the full cost of providing and cleaning the water. That's a big problem. There is a growing need for higher water and sewer rates to pay for the true cost of this important service.

Pollution

Water supply and water quality are closely related topics. People everywhere are concerned about having enough good quality water. Polluted water can keep us from enjoying recreational opportunities such as fishing, swimming, and boating. It may also kill fish and wildlife, destroy their habitat, or interfere with their ability to produce young. This has led our federal, state, and local governments to create new laws to help reduce pollution of our water supplies and to set standards for drinking water. Federal law says waste water must be cleaned. The government has set 1985 as the goal to achieve "fishable and swimmable waters."

There are two basic sources of water containing pollution—one is called point source pollution and the other non-point source pollution. Point source pollution is the type of pollution the government has the most laws to stop or reduce. Point source pollution may also come from the sewage of cities, towns, and

villages and can hurt water quality unless special sewage treatment occurs.

Non-point source pollution is caused by runoff that carries chemicals, acids, and sediment from large agricultural, mining, logging, or construction sites, or from urban streets and parking lots. Runoff that contains an excess of nutrients, such as phosphorous and nitrogen, will enter a lake or stream and encourage abnormal plant growth. The growth is called algae. It is the green slime you sometimes see on water surfaces. More than 40 percent of the phosphorous in Lake Erie comes from runoff from farm lands.

Preventing non-point source pollution is a challenging political problem because controls often relate to the sensitive issue of how people use their land. People often do not like to be told by the government what they can and cannot do with their land.

Waste water is disposed of in Ohio streams and lakes every day. Steam-electric generating plants also return water to the rivers. The power plants require huge amounts of water, much more than any other use in Ohio, for cooling equipment and driving turbines. However, strictly enforced state and federal regulations assure that water from cities and industries isn't seriously polluted, contaminated, or too warm when returned to the stream. Many other wastes are washed into our waterways from the atmosphere or land surface during storms. Our laws do not adequately control these water pollutants.

Treatment is expensive and it costs all of us a lot of money. Cities in Ohio have spent millions of dollars on new sewage treatment plants, and more advanced treatment plants are needed. The total clean water bill could be phenomenal. A family in town pays from 30 to 40 cents a day as its share of the cost of the municipal waste-water treatment plants. However, the costs of allowing water pollution to continue could be even more phenomenal. Can you name some of the costs caused by water pollution? The following table might help you.

MAJOR POLLUTANTS	WHERE THEY COME FROM	WHAT THEY DO
Organic wastes	Human and animal sewage, factories.	Can cause diseases that keep us from using water for drinking, swimming, or fishing. Can use up oxygen that fish need to live.
Sediment	Farming, logging, road building, and other construction activities that disturb the land.	Reduces the amount of sunlight that can penetrate the water and reach plants. When it settles, sediment covers bottom habitat, sometimes killing larvae and eggs.
Acids	Industry, mine drainage.	Can affect fish and keep them from reproducing. Eats away at pipes in water supply systems.
Oil and grease	Refineries, heavy industry, and street washing.	Washes up on shorelines and beaches, damaging fish and waterfowl.
Plant nutrients such as phosphorous and nitrogen	Fertilizers and sewage. Phosphorous is used in many detergents.	Plants such as algae grow rapidly, using up oxygen that fish need to live. Can destroy the usefulness of water bodies for fish, recreation, and water supply.
Heated water	Power plants, some factories.	Abnormal changes in temperature can upset the balance and number of species.

Floods

Flooding is a natural event. When a river cannot contain all of the runoff water within its normal banks, flooding occurs. The land next to the river is called the floodplain and acts as a natural "safety valve" to relieve the river and temporarily store and carry away flood water.

In Ohio, flooding wasn't really a problem until people moved into the floodplains. Floods occurred, of course, but they were not a problem until people and property were damaged.

There are several reasons why people choose to live in such potentially dangerous places. Floodplains are deceptive because they aren't usually covered by water. Because they are formed by water, they are normally very flat and easy to build on. Early farmers settled in the floodplain because the soils were well drained and fertile. Towns sprang up in floodplains as the nearness of water provided an inexpensive means of transportation for people and products. Water also holds a special appeal for people—they simply enjoy living near water. But there is a price on use of the floodplain.

In Ohio alone, there are tens of millions of dollars in flood damage every year. Disastrous floods in Ohio during 1913, 1959, and 1969 killed many people and wreaked havoc throughout much of the state. The flood damage and destruction was so great that it motivated people to try to protect themselves, their cities, and their industries from future floods. As a result, the Ohio Conservancy Act was passed after the 1913 flood and gave people an organized way to control local flooding.

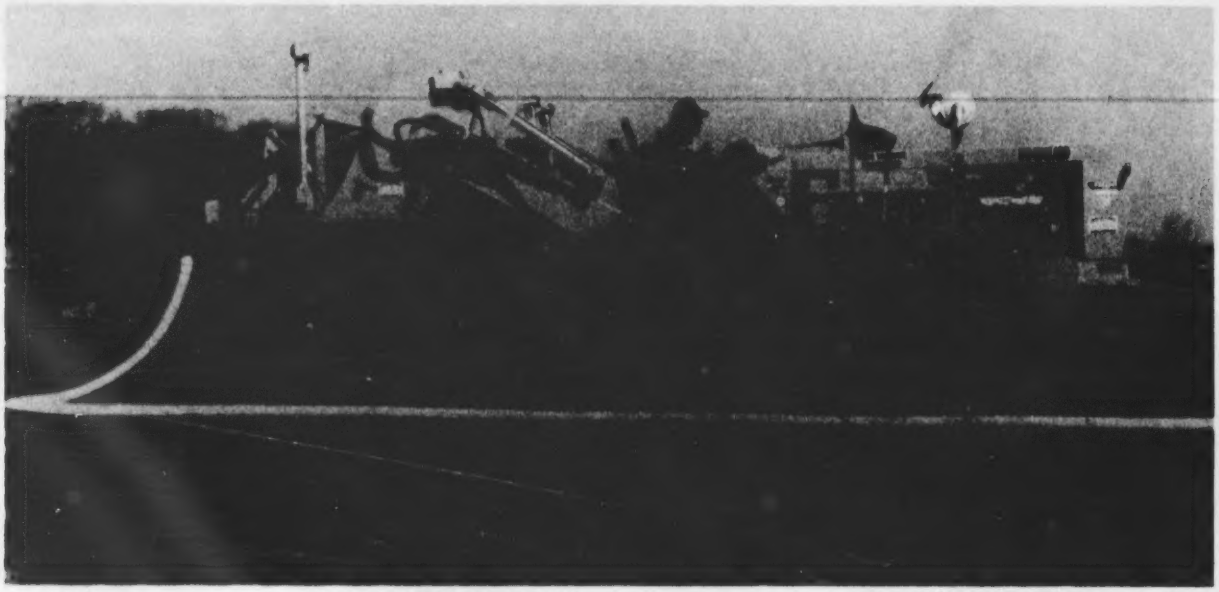
In the Miami River Valley near Dayton, the 1913 flood hit the hardest and caused severe damage. The Miami Conservancy District was organized in 1915. Five flood-control dams, as well as other flood protection works, were built by the District. These works were paid for by local people, to protect cities, towns, industries, and other property in the valley.

Since then, with the help of federal funding through the U. S. Army Corps of Engineers, 29 flood-control dams have been built in other areas of Ohio. Another federal agency, the Soil Conservation Service, helps reduce flood hazards to agricultural lands with land treatment (conservation farming practices) and structural measures (dams, dikes, or levees).

We can't expect to control all floods—the cost would be incredible. But we can lower the threat of flood damage through the proper management of our floodplains. Flood protection such as dams, dikes or levees is expensive. Floodplain management practices do not eliminate use of the land near our streams, but they do encourage compatible uses such as parks and recreation areas that aren't heavily damaged when flooded. Zoning, subdivision regulations, building codes, sanitary codes, and governmental land purchase regulate where and how development in the floodplain may occur. For many homeowners already living in flood-prone areas, flood insurance is the only means available to protect their property from flood losses.

AKRON BEACON JOURNAL
MOUNT VERNON NEWS
FLOOD-STRICKEN CITY WORKS TO RESTORE ESSENTIAL SERVICE
TOLEDO BLADE
CLEVELAND NEWS HOME
4 KILLED, 5 MISSING HERE, RAIN LOSS HITS 1¼ MILLION

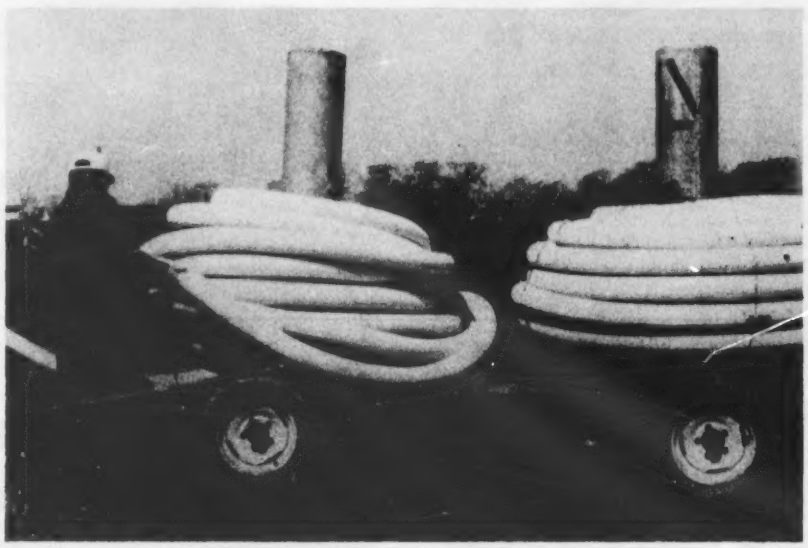
Agricultural Drainage



Poor drainage is a major water problem on more than half of Ohio's farm lands. Just as you can't use your sink when it's stopped-up, a farmer can't plow, plant, or harvest good crops on farm land that is too wet or poorly drained. Crop yields on well-drained soils can be as much as 50 to 100 percent higher than on the same soils without good drainage.

Ohio has one of the most extensive subsurface drainage systems in the United States. But wet cropland soils remain a serious problem. Our most serious drainage problem is in the rich, flat lands of northwest Ohio. Once swampland and now artificially drained, the soils in this part of the state are mostly clays and silts. The soils are fertile and good for farming but drain very slowly. The fantastic agricultural productivity in northwest Ohio depends entirely on providing and maintaining drainage systems for the wet soils.

Maintaining the drainage systems presents unique problems to water managers. To the farmer, keeping waterways from filling with sediment and blocking tile drainage outlets often means dredging, enlarging, or straightening the channel. This approach is often challenged because it changes the stream environment and can eliminate or reduce fish habitat and wildlife food and cover. Maintaining agricultural and environmental interests can be delicate work.



23

Urban Drainage

Poor drainage can also be a problem for those who live in cities. Storm drainage troubles grow as a city grows. Where the ground is covered with impervious surfaces such as streets, parking lots, driveways, and rooftops, stormwater cannot enter the soil and may overload the storm sewers, causing flooding. Where does the extra rainwater go? Some may end up in your basement or as a small pond in your back yard. If the area you live in was built using a good drainage plan, the stormwater probably collects in a retention pond or drains away through large sewer pipes.

At least 13 Ohio counties have developed urban stormwater control regulations. More than 32 cities and towns also have laws to deal with this problem. State officials estimate that correcting urban drainage problems for areas already developed would cost billions of dollars.

Sedimentation

That muddy look in many Ohio streams is caused by sediment. This is soil that comes from the erosion of the land and from the natural processes of streams and rivers that cut away their banks and beds.

Erosion has been going on since the Earth began. Some of our streams were muddy long before we cut down the forests and plowed our fields. The diaries of early explorers tell us that. But poor farming, forestry, mining, and construction practices are aggravating the problem. Soil conservation practices such as strip cropping, contour plowing, no-till farming, terracing, construction of grassed waterways and debris basins, and reforestation are helping to prevent some of our soil losses.

In terms of water supply and flood control, sediment causes some of its greatest damage by settling in reservoirs, reducing the amount of room left for storing water. City water supply managers are interested in reducing sedimentation because sediment and accompanying pollutants can be very expensive to remove from our drinking water.

Water Management

What's the Answer?

So far in this booklet we have looked at a few of the many water problems—shortages, pollution, flooding, agricultural and urban drainage, and sedimentation. You might be wondering what answers we have, if any, for solving Ohio's water problems. What can be done to manage our remarkable water resource in the best way?

Perhaps the key word is management. We can do a great deal by using management techniques such as planning, research, preparation and implementation of workable legislation, and education.

When we make plans with our time—such as where to go next weekend—we look ahead and study alternatives. Water planning is similar. Planners determine what choices we have and what the advantages and disadvantages are with each alternative. For example, a growing city might need more water to serve people who have moved to the area. What should the city do? Drill wells, build a reservoir, buy and bring water from another city, or require less water use? While the final decision rests with the city, technical and sometimes financial help is available from many state and federal water management agencies.

Water plans for five regions that make up the entire state have been published by the Division of Water within the Department of Natural Resources. The plans serve as general guides to community leaders for ways to meet future water demands. They are good examples of comprehensive water resource planning and should be periodically revised.

Research and data gathering are tools that can lead to better answers to practically any water problem. Research got us to the Moon, didn't it? In recent years, research in waste-water treatment has paid big dividends. We now know much more about how to effectively clean our waste water so it can be safely reused.

As with good planning, research should be a continuous process. We need to keep looking for more economically, environmentally, and socially sound ways to use, store, clean, and move water. Research is a sturdy tool for better planning.

Sometimes water management issues get so complicated, it takes a legal opinion to straighten things out. Because we have abundant water in Ohio, our water laws are simple and less defined compared to water laws of drier western states where every drop of water in a river might be owned and used by someone. But we are rapidly approaching the time when more detailed water legislation will be needed to resolve issues, like multi-county drainage and flooding, which affect many people.

Before any of us make a decision about a water problem, we need to know something about how water works. We need a background—a basic water education. Don't you agree? Perhaps that is why you read this booklet, which is all about our remarkable water resource. Part of the answer lies in water education—in encouraging you to continue your study of water problems and future water needs and then to make wise decisions based upon what you have learned.

The answer is not an easy one. But with sound water planning, research, legislation, and education, we are off to a good start in finding the best way to manage Ohio's remarkable water resource.

Water Words

Several of the more common water words and terms are briefly described in the following glossary. For further references on water-related subjects, a publications list is available from The Ohio Department of Natural Resources, Division of Water, Fountain Square, Bldg. E, Columbus, Ohio 43224.

a

Aquifer
A water-yielding underground layer of rock, sand, or gravel that can be entered by water, or is permeable.

b

Base Flow
The stream discharge from ground water. The amount of water that is present in a stream after surface runoff from precipitation is gone. Can generally be seen during dry seasons.

d

Discharge
Rate of flow. As used in this booklet, discharge means water movement. Commonly expressed as cubic feet per second, million gallons per day, gallons per minute, or cubic meters per second.

Discharge of Ground Water
Occurs when water flows out from underground. Ground-water discharges are often seen as springs.

e

Ecosystem
An interrelated system made up of a community of animals, plants and microorganisms and the physical, chemical, and biological environment in which they live.

Environment
An organism's surroundings. Water is a major part of most organisms' surroundings.

Erosion
The wearing away of the Earth's surface by water, wind, or ice. Erosion occurs naturally from weather or runoff, but it can be made worse by how the land is used.

Evaporation
Change in water from a liquid that can be seen to a vapor that can't be seen.

f

Flooding
Overflow of a stream or other body of water.

Floodplain
A strip of nearly flat land next to a stream or river. It is formed from sediment carried by the stream and dropped when water floods the area.

g

Ground Water
Water held in the rocks and soil, replenished according to climate and the local geology and variable in both amount and quality. There is some water under the Earth's surface almost everywhere.

h

Hydrologic Cycle
The pathway water follows in moving from the atmosphere to the Earth and back to the atmosphere.

i

Impervious
The resistance to penetration by water or plant roots. A paved parking lot is impervious to water.

Impoundment
Generally, an artificial collection or storage of water such as a reservoir, pond, pit, or dugout. See reservoir.

Infiltration
The entry of water from the Earth's surface into the soil.

Irrigation
Putting water on land to help plants grow.

l

Lake
An inland body of water, usually fresh water, formed by glaciers, or river drainage, and is larger than a pool or pond. Bodies of water filling depressions in the Earth's surface. Reservoirs built by people are often called lakes, too.

Liquid
A state of matter, neither gas nor solid, that flows and takes the shape of its container.

p

Precipitation
Moisture falling from the atmosphere as rain, snow, sleet, or hail.

Photosynthesis
A process in green plants through which water, carbon dioxide, and sunlight combine to form sugar.

Pore Space
That portion of rock or soil not occupied by solid matter and which may be occupied by ground water or air.

r

Rain
Water drops that fall to the Earth from the air.

Recharge
The addition of water into an aquifer.

Reservoir
A lake built by people to collect and store water.

Runoff
The portion of rain, melted snow, sleet, and hail, or irrigation water that flows across the land surfaces and eventually runs into streams.

s

Sediment
The soil particles that are moved from one place to another by water as a result of erosion.

Subsurface Water
All water below the surface of the Earth. Ground water is a type of subsurface water.

Surface Water
All water on the surface of the Earth in oceans, lakes, and streams.

t

Transpiration
Release of moisture from plants into the air.

w

Water
The liquid that falls from the clouds as rain, forms streams, lakes, oceans and other water bodies, and is a major part of all living matter.

Water Management
Applying methods to get added benefits from water in any number of areas such as flood control, navigation, irrigation, drainage, wildlife and recreation, water supply, watershed management, and water storage in soil for crop production.

Water Pollution
Addition of material that makes surface or subsurface water unclean and unfit for some uses by humans.

Water Table
Level in the Earth below which all pore spaces in the soil are full of water, or saturated.

Watershed
All the land that drains into a single surface water body such as a stream or lake. It may be very large, like the Ohio River basin that covers thousands of square miles, or it may be very small such as the few acres that drain into a farmer's pond.

Well
A pit, hole, or shaft sunk into the Earth to tap an underground supply of water.